

Diversity of spiders (Araneae) in the diet of Edible Frog (*Rana esculenta* complex) in a protected wetland area in Hungary

By
K. SZATHMÁRY*

Abstract. This study deals with spiders obtained by stomach-flush method from 75 specimens of the Edible Frog (*Rana esculenta* complex) caught in wetland of the Kis-Balaton Nature Reserves in Hungary. We found 140 exemplars of spiders (Araneae) belonging to 47 taxa from the stomach contents of the frogs. Some differences were observed in the diet-structure of *Rana esculenta* living in the three investigated areas. As compared the present results to the former ones, we have found higher spider diversity in the feed of frogs in 1992 than before.

The study area is a protected wetland (Kis-Balaton Nature Reserves Hungary) close to Lake Balaton, by the mouth of the River Zala (Fig. 1). The water of Zala becomes clearer flowing across this wetland. Reflooding works started in this area in 1984 and helping this process a large artifical water reservoir having been built.

Since 1984 a lot of studies have tried to follow the changes in structure and diversity of the fauna following this strong intervention. Among them, investigations were carried out on anurans. The anurans are generalist feeders, so their diet as could be expected reflects the diversity of Arthropoda and other Invertebrata living in the area. Our aim is to monitor the long term changes in composition in the invertebrate communities being potential prey of the frogs.

Only few papers have been published on the feed composition of the anurans. After the early publications (MOLNÁR, 1967; RAINISS, 1959; SZABÓ, 1957; TYLER, 1958), there are some new studies on this theme (KOVÁCS & TÖRÖK, 1992, 1993, 1994; TÖRÖK & CSÖRGÖ, 1992; TÖRÖK & KOVÁCS, 1996) and especially on the Edible Frog (*Rana esculenta* complex) populations (KOVÁCS & TÖRÖK 1995, 1995). The author is studying the spiders (Araneae) found in the stomach contents of frogs and its composition from different sampling sites (SZATHMÁRY, 1996; SZATHMÁRY & KOVÁCS, 1995).

The spiders fed by anurans can be well identified, they remain fairly intact in the stomach; if they are in bad condition their strongly chitinised parts (cheliceras, sternum, epigyne, pedipalpus) are still useful for identification.

Material and methods

The spiders were obtained with stomach-flush method (LEGLER & SULLIVAN, 1979) from 75 specimens of Edible Frog (*Rana esculenta* complex) from the wetland of the Kis-Balaton Nature Reserves in Hungary. The stomach-flushing is a tactful method for the

* Kinga Szathmáry, ELTE Állatrendszertani és Ökológiai Tanszék, MTA Talajzoológiai Kutatócsoport (Department of Systematic Zoology and Ecology of the Loránd Eötvös University, Section of Soil Zoology of the Hungarian Academy of Sciences), 1088 Budapest, Puskin u. 3, Hungary.

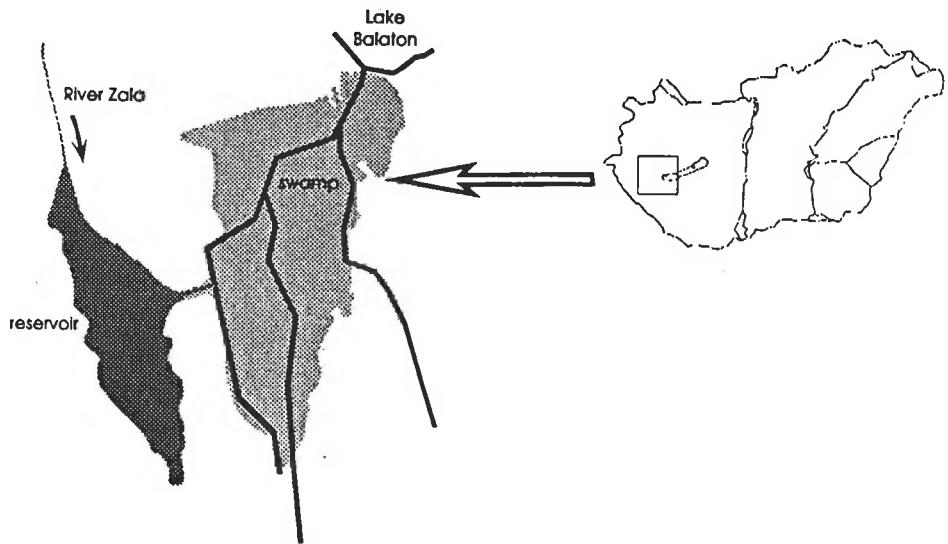


Fig. 1. Location of the investigated area

Table 1. List of spider species found in the stomach contents of Edible Frog (*Rana esculenta complex*) caught in Kis-Balaton Nature Reserves in Hungary in 1992

Rana esculenta complex	Indiv.	Diás Island	Reservoir	Babos Island
GNAPHOSIDAE	4	1	3	
Drassodes pubescens	2		2	
Haplodrassus silvestris	1		1	
Zelotes sp.	1	1		
CLUBIONIDAE	28	10	15	3
Clubiona spp.	8	2	4	2
Clubiona compta	3	2	1	
Clubiona pallidula	1		1	
Clubiona phragmitis	15	5	9	1
Agroeca sp	1	1		
ZORIDAE	1	1		
Zora sp	1	1		
THOMISIDAE	8	4	2	2
Xysticus spp.	4	1	1	2
Xysticus cristatus	1		1	
Xysticus lanio	1	1		
Xysticus ulmi	2	2		
SALTICIDAE	1	1		
Marpissa sp.	1	1		
LYCOSIDAE	47	22	13	12
Lycosida spp.	2	2		
Pardosa spp.	10	3	4	3
Pardosa amentata	1	1		
Pardosa lugubris	2	2		
Pardosa paludicola	1			
Pardosa prativaga	5	3		
Alopecosa spp.	3	2		1
Trochosa ruricola	3	1	2	
Arctosa spp.	3	2		
Arctosa cinerea	3	3		
Arctosa personata	1			1
Pirata spp.	10	3	5	2
Pirata piraticus	2		2	
Pirata tenuitarsis	1			1
Rana esculenta complex	Indiv.	Diás Island	Reservoir	Babos Island
ARGYRONETIDAE	14	3	10	1
Argyroneta aquatica	14	3	10	1
HAHNIIDAE	2	2		
Antistea elegans	2	2		
THERIDIIDAE	4	2	1	1
Dipoena sp.	1	1		
Enoplognatha sp.	1		1	
Enoplognatha mandibularis	1			1
Robertus arundineti	1			1
TETRAGNATHIDAE	7	5	1	1
Tetragnatha pinicola	1			1
Pachygnatha clercki	2		1	1
Pachygnatha degeeri	4	4		
ARANEIDAE	9	2	6	1
Araneida spp.	5	1	3	1
Larinoides cornutus	4	1	3	
LINYPHIIDAE	15	5	8	2
Linyphida spp.	8	3	3	2
Donacochara speciosa	2		2	
Erigone sp.	1		1	
Floronia bucculenta	1			1
Microlinyphia impigra	1	1		
Oedothorax agrestis	1			1
Walckenaeria sp.	1	1		
Spider specimens	140	58	59	23
Spider species	47	31	22	18
Investigated frogs (ind.)	75	25	34	16

amphibians, because they stay alive after the process. The stomach contents were preserved in metil-alcohol, then they were sorted in the laboratory and the spiders were determined under microscope by the author.

There are three investigated areas throughout the wetlands: 1. Diás Island, surrounded by undestroyed swamp; 2. along the shore of the large water reservoir (by Fekete Island), surrounded by reef beds and tufts; 3. Babos Island, a meadow with poplar trees (Fig. 1). The spiders are from 25 specimens of frogs from the Diás Island, 34 from the shore of the reservoir and 16 from the Babos Island. Collecting was carried out at least once a month from April to September in 1992.

Results

Comparison of the present and the former results

In the present study we have found (in 1992) 140 specimens of spiders (belonging to 47 taxa from 12 families) found in stomachs of 75 Edible Frogs from the wetland of Kis-Balaton Nature Reserves.

In the material collected in 1984 only 9 exemplars of spiders (indet.) were observed from the stomachs of 47 Edible Frogs in the same area (Kis-Balaton Nature Reserves) (TÖRÖK & CSÖRGÖ, 1992). Publications covering different parts of Hungary (SZABÓ's collection, 1956-61) have mentioned 20 spiders (13 species belonging to 7 families) from 55 Edible Frogs (SZABÓ, 1957; TÖRÖK & CSÖRGÖ, 1992). There is no mention in the former papers about *Argyroneta aquatica*, the only spider species is living permanently in water. This species was present in the diet of *Rana esculenta* with a surprisingly high number (14 specimens) in 1992, especially near to the reservoir (10 specimens).

Comparison of the three collecting sites

There are some differences in the spider composition in the feed of Edible Frogs collecting in the three investigated sites. In total we found 140 spiders in the stomach-contents of the 75 anurans: 58 spiders from the Diás Island, 59 from the shore of the reservoir and 23 from the Babos Island. The list of the spider species can be seen in Table 1.

The differences in the spider family composition in the nutrient of Edible Frogs are represented on bar graphs (Figure 1). Most of the families (12) were found in frogs in the Diás Island, the least (8) was in frogs of the Babos Island. Lycosid and clubionid spiders were represented in the highest percentage in all three the sites but in different rates. The other spider families are present in dissimilar percentage. *Argyroneta aquatica* was found in all three collecting sites from the feed of anurans; the most (17%) by the reservoir. The web builder spider families (Theridiidae, Tetragnathidae /partim/, Araneidae and Linyphiidae) were also represented (about 25%) in the frog diet, not only the hunters.

Discussion

In this study we have found more spider specimens, species and families in the feed of the Edible Frog than were published in the former papers. We suspect that the diet of the anurans well reflects the invertebrate fauna living in an area, because the anurans are generalist feeders within the adequate size spectrum of the fauna (TÖRÖK & CSÖRGÖ,

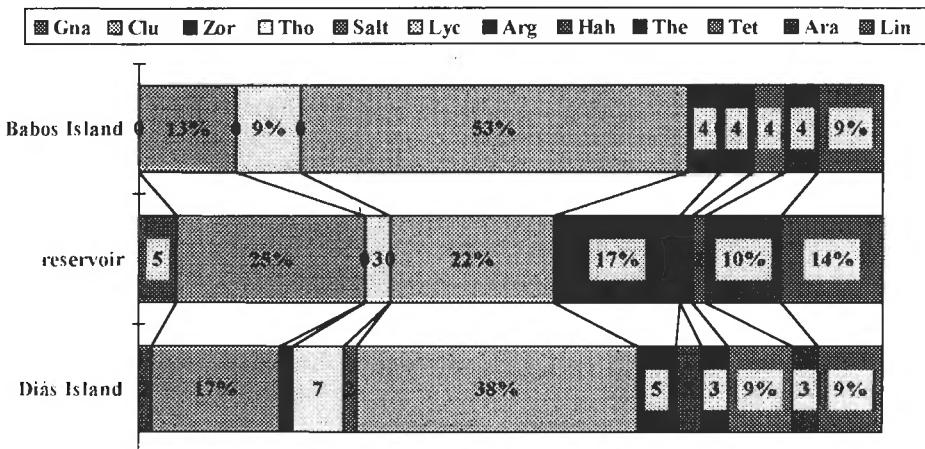


Fig. 2. Spider-family composition in the diet of Edible Frog found in three collecting sites in Kis-Balaton Nature Reserves, Hungary in 1992 – (Families: Gna=Gnaphosidae, Clu=Clubionidae, Zor=Zoridae, Tho= Thomisidae, Salt=Salticidae, Lyc=Lycosidae, Arg=Argyronetidae, Hah=Hahniidae The=Theridiidae, Tet=Tetragnathidae, Ara=Araneidae, Lin=Linyphiidae. Investigated frogs: Diás Island: 25, reservoir: 34, Babos Island: 16 specimens. Found spiders: Diás Island: 58, reservoir: 59, Babos Island: 23 specimens)

1992). The recent results show higher diversity of spider fauna in 1992 than it had been mentioned by the previous publications.

As for the distribution of the spider families in the diet of anuran communities, we have noted some differences among the collecting sites. The highest spider diversity was observed on the island (Diás Island) which was inside the undisturbed swamp. Lower diversity was along the shore of the reservoir, where the flora and fauna have been regenerated more or less after the technical intervention. The lowest spider diversity was observed on a relatively drier meadow (Babos Island).

It is not surprising that the families Clubionidae and Lycosidae occur in the highest proportions in all three places. These spiders are hunters and a large number of species lives in wetlands. It is interesting that the web builder spider families - like Theridiidae, Tetragnathidae in part, Araneidae and Linyphiidae - are also present in the frog diet in about 25 per cent. An other remarkable observation is the high number of *Argyroneta aquatica*, the only definitely aquatic spider. This spider was the part of the prey of anurans on every collecting site but in the largest percentage (17%) near the reservoir. Here is a peaceful part of water full with aquatic plants which is an ideal habitat for *Argyroneta aquatica*.

After all these results we gained data enabling us to monitor the coming changes in the wetland of the Kis-Balaton Nature Reserves.

*

Acknowledgement. This study has been supported by OTKA Foundation (theme number: T 017690).

REFERENCES

1. CHYZER, C. & KULCZYNKI, L. (1892-97): *Araneae Hungariae*. – Budapest, I. 1892, II. 1894-97.
2. HEIMER, S. & NENTWIG, W. (1991): *Spinnen Mitteleuropas*. – Berlin und Hamburg, 1-543.
3. JONES, D. (1983): *Spiders of Britain and Northern Europe*. – Middlesex, England, 1-320.
4. KOLOSVÁRY, G. (1933): *Az Argyroneta aquatica nagybalatoni előfordulása*. – A Magyar Biológiai Kutatóintézet I. Osztályának Közleményei, 6: 145-147.
5. KOVÁCS, T. & TÖRÖK, J. (1992): Nyolc kétéltű faj táplálékkösszetétele a Kis-Balaton Természetvédelmi Területen. – Állatt. Közlem., 78: 47-53.
6. KOVÁCS, T. & TÖRÖK, J. (1993): A long-term restoration project in a protected wetland area of Hungary. – Wildlife Management Congress, San Jose, Costa Rica.
7. KOVÁCS, T. & TÖRÖK, J. (1994): Kétéltű fajok táplálékprefereciájának szezonális változása a Kis-Balaton Természetvédelmi Területen. – III. Magyar Ökológus Kongresszus, Szeged.
8. KOVÁCS, T. & TÖRÖK, J. (1995): Change in diet diversity of Edible Frog (*Rana esculenta* complex) in protected wetland area (Western Hungary) during a long term project. – International Conference on Wetlands and Developments. Selangor, Malaysia, 1995.
9. KOVÁCS, T. & TÖRÖK, J. (1995): Diet plasticity of the Edible Frog (*Rana esculenta* complex) in a protected wetland area in Hungary during a 9-year period. – 7th European Ecological Congress, Budapest.

10. LEGLER, J. M. & SULLIVAN, L. J. (1979): The application of stomach-flushing to lizards and anurans. – *Herpetologica*, 35: 107-110.
11. LOCKET, G. H. & MILLIGE, A. F. (1986): *British spiders*, 1, 2. – London.
12. LOKSA, I. (1969): Pókok I. – *Araneae I*: – In: *Magyarország Állatvilága, Fauna Hungariae*, 18, 2: 1-133.
13. LOKSA, I. (1972): Pókok II. – *Araneae II*: – In: *Magyarország Állatvilága, Fauna Hungariae*, 18, 3: 1-112.
14. LOKSA, I. (1981): Pókok - *Araneidea*. – In: Móczár, L.: *Állathatározó 2.*, 515-568.
15. MOLNÁR, GY. (1967): Ivdéknévelő tavak közelében élő békák gyomortartalom-vizsgálata. – *Agrártud. Egyet. Közlem.*, 29-36.
16. RAINISS, L. (1959): Táplálkozásbolgárai vizsgálatok kecskebékán. – *Halászat*, 6: 110-111.
17. ROBERTS, M. J. (1985): *The spiders of Great Britain and Ireland* 1, 2. – Colchester, England.
18. SAUER, F. & WUNDERLICH, J. (1985): *Die schönsten Spinnen Europas*. – Karsfeld.
19. SZABÓ, I. (1957): Kéréltűek és hüllők jelentősége entomológiai gyűjtésekben. – *Rovart. Közlem.*, 12: 185-192.
20. SZATHMÁRY, K. & KOVÁCS, T. (1995): What kinds of spiders (Araneidea) do the frogs and toads consume in Kis-Balaton Nature Reserves, Hungary? – 7th European Ecological Congress, Budapest. (Abstract.)
21. SZATHMÁRY, K. (1996): A kis-balatoni pókok - mint békátplálék. – 2. Kis-Balaton Ankét, Keszthely, Ankét kötet, 373-379. old.
22. TÖRÖK, J. & CSÖRGÖ, T. (1992): Food composition of three *Rana* species in Kis-Balaton Nature Reserve. – *Opusc. Zool. Budapest*, 25: 113-123.
23. TÖRÖK, J. & KOVÁCS, T. (1996): Long-term investigation of the amphibian populations in Kis-Balaton Landscape Area. – Scientific Programme of the Symposium on "Research, Conservation, Management", Aggtelek-Jósvafő. (Abstract.)
24. TYLER, M. J. (1958): On the diet and feeding habits of the Edible Frog (*Rana esculenta* Linnaeus). – *Proc. Zool. Soc. London*, 131: 583-595.